Population Status, Reproduction, and Mortality of Purple Martins in Sacramento during 2007

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In 2007, we continued ongoing studies and management actions for the Purple Martin (*Progne subis*) in the Sacramento region. The species is identified as a species of special concern (California Department of Fish and Game 2007, Airola and Williams 2008) and has been eliminated from California's Central Valley, except for the remnant bridge-nesting population in Sacramento (Airola and Grantham 2003, Airola and Williams 2008.) We continued monitoring the population and assessing mortality factors. We also conducted the first examination of reproductive success, which has been identified as a long-term gap in the understanding of this population (Airola and Kopp 2007).

STUDY AREA

We studied martins at previously described bridges in Sacramento that were occupied or considered suitable for use by Purple Martins (Airola and Grantham 2003, Leeman et al. 2003) and re-surveyed a previously occupied site in the City of Davis (Airola et al. 2004). Surveys conducted in Roseville, Placer County were reported previously (Kopp and Airola 2007), but results are incorporated into regional totals for this paper.

METHODS

Population Monitoring

We used population survey methods previously described (Airola and Grantham 2003, Leeman et al. 2003, Airola and Kopp 2007). Highly experienced surveyors conducted all 2007 surveys. We confirmed breeding by 95% of breeding pairs through diagnostic nesting behaviors, rather than inferring breeding from frequencies of hole-use. This rate of confirmation is the highest of any survey year and thereby provides high reliability to population estimates.

2007 was the first year in which we evaluated martin reproduction in Sacramento. Because nest sites are not directly accessible, we used a Speco Technologies CVC model 50BC black-and-white mini-camera with custom-built visible and infra-red ("dark vision") LED light sources. We mounted the camera on a 12-m telescopic pole and connected it to a Sony TRV-230 digital camcorder. The black-and-white video camera is sensitive to infra-red illumination, which is invisible to the eye, allowing observation of nests in dark bridge chambers without causing disturbance with bright visible light. Notably, we observed no indications that our monitoring caused any premature fledging of young (i.e., young leaving the nest cavity during or after monitoring, or detection of premature "fallouts" beneath the nests).

We chose nest sites for monitoring based on earlier observation of nest building. Thirty-six nests were examined at four colonies (I St., S St., Arden, and El Camino; see Leeman et al. 2003 for locations). Each site was checked 5-7 times at 3- to 11-day intervals (average = 6 days) over a 29-day period. We recorded video images, sorted, and assembled them by nest site, and then viewed them to count number of eggs and young. We assigned ages to young by comparing images to reference photos (Hill 1999).

At various times, several factors obstructed or otherwise inhibited our ability to make accurate counts of eggs and young. Construction materials within some chambers obstructed views of some nests and young. Brooding adults and leaves placed over eggs by adults during absences generally precluded accurate counts of eggs. Younger nestlings sometimes huddled all together, making counts of individuals difficult. Low light intensity and the resulting low resolution of images sometimes inhibited counts of older nestlings farther from the camera.

To address the varying quality of video observations, we rated the quality of each observation (high, moderate, or low) based on the likelihood that we obtained an accurate count (i.e., based on the extent of visual disruptions, distance of nestlings from holes, and behaviors that influenced our ability to detect and accurately count young). We then examined counts recorded for each nest and retained those counts from observations that were of medium and high quality ("adequate"). We present standard values for nesting success (% of nest producing at least 1 young) and productivity (number young/occupied nest; Cousens and Airola 2006) for 28 nests (5-8 per colony) that we determined to have been adequately monitored.

For several reasons, we calculated productivity based on numbers of nestlings present during the period when young were 14-20 days old, even though martins typically fledge at 28-29 days of age (Brown 1997), and we monitored typically through age 25-27 days. First, using counts at 14-20 days facilitated comparison with other nest box studies of martins, where nests typically are not checked after young are 20 days old, to avoid causing premature fledging of young (S. Kostka and B. Cousens, pers. comm.). Also, movements of more

mobile nestlings older than 20 days within the large bridge nesting chambers may have allowed some young to escape detection. As a result, we may not have detected some mortality of older nestlings, although <10% of nestlings >14 days old die before fledging in British Columbia (Cousens, pers. comm.).

Adult and Nestling Mortality

We continued our annual surveys for dead or injured adults and nestling "fallouts" beneath and adjacent to colonies (see Airola and Grantham 2003, Airola and Kopp 2005, 2007). Notably, fallouts included young that accidentally fell from nests but also could have included those that died in the nest and were discarded by adults for nest sanitation or those removed from nests during raids by second-year males.

Feral Cat Observations

As a follow-up to the substantial decline in the nesting population at I St. in 2006, which we suggested may have been caused by predation by feral cats (Airola and Kopp 2007), we continued monitoring feral cats in 2007. We monitored cat abundance and behavior near the colony incidental to other activities for a cumulative total of approximately 30 hrs. Cat numbers also were determined through direct observation and discussion with an anonymous individual who maintained the feral cat feeding station near the martin colony (see Results). We also evaluated whether martin population changes at I St. in 2007 differed from changes at the other colonies, which could suggest that cat predation was an important mortality source there.

Land Use Threats

In response to population declines observed prior to and during 2007, we evaluated potential threats of land use projects that may pose a risk to Purple Martin colonies and their treatment in environmental planning documents. We evaluated projects that included or were adjacent to martin colonies, based on environmental documents and discussions with involved individuals. We assessed threats at a general level based on their potential to directly disturb nesting pairs, alter important habitat elements (i.e., known perch sites, nest material collection sites, flight access and foraging air space, as determined from direct observation of uses during 2002-2007) or increase vehicle mortality, starling competition, and establishment of human-subsidized feral cat populations. Our assessment of projects was not intended as a definitive critique of project environmental analyses, but rather to evaluate whether and how potential effects were addressed during project planning and analysis.

RESULTS

2007 Population

The number of sites occupied by breeding martins remained at 11 in 2007 (Table 1). The Airbase colony, which supported only 1 breeding pair in each of the two previous years, did not support nesting, although a single after-second-year male martin was seen at the site during one visit. The new

Table 1. Breeding Purple Martin pairs at Sacramento colony sites in 2007 and recent years[a]

Colony[b]	2002	2003	2004	2005	2006	2007
I Street	37	29	35	32	17	11
20th Street	14	21	23	23	16	15
Sutterville	4	6	8	5	6	6
Broadway	8	7	7	7	5	1
S Street	14	14	16	14	18	9
35th Street	29	19	15	14	6	3
Redding Rd.	0	3	12	10	14	14
El Camino	ns[c]	15	23	21	21	20
Marconi	ns	1	4	3	0	0
Roseville Rd.	29	39	27	24	24	17
Arden	ns	0	3	6	13	9
Airbase	ns	0	0	1	1	0
Pole Line	ns	2	0	0	0	0
Hwy 65/Taylor	ns	ns	ns	ns	ns	1
Total	135	156	173	160	141	106

[a] Numbers reported represent pairs reaching nestling stage. Previous year's populations from Airola and Grantham (2003), Leeman et al. (2003), Airola et al. (2004), and Airola and Kopp (2005, 2007).
[b] See Leeman et al. (2003) for a description of colony locations
[c] ns = no site survey conducted that year.

State Route 65 site in Roseville, Placer County, first surveyed in 2007, was occupied by a pair of martins that contained a subadult male, while 3 other nearby suitable sites were unoccupied (see Kopp and Airola 2007). All other sites occupied in 2007 had been occupied in 2006. One second-year male was observed at Interstate 50 at La Riviera Dr. and Folsom Blvd., but no nesting occurred. The formerly used Marconi and Pole Line (Davis) sites again did not support nesting pairs.

A total of 106 pairs bred at Sacramento region colonies, representing a decline by 25% from the 2006 population and a 39% decline from the peak population in 2004 (Table 1). Nesting populations decreased at 9 of 11 colonies occupied in 2007, while numbers at two colonies remained the same. Between 2006 and 2007, colonies in more highly urbanized downtown and "midtown" areas (I St., 20th St., Broadway, 35th St. and S St.) , declined by more (-37%) than did the other less urbanized peripheral colonies (-15%). The difference in declines, however, did not vary significantly from an equal pattern of decline at all sites ($\chi^2_{1\ d.f.} = 1.29$, $p = 0.26$).

Reproductive Monitoring

Twenty-seven (96%) of the 28 monitored nests were successful in producing at least one young. Productivity at Sacramento colonies averaged 3.4 young per nesting attempt. Nest success and productivity were generally similar across all colonies, with nest success at different colonies ranging from 88-100% and average productivity varying from 2.9 to 3.8 young per nesting attempt. We observed no evidence of predation or starling competition within nesting chambers.

Adult and Nestling Mortality

We found 4 dead adults (1.9% of the total breeding population) at colonies that were attributed to vehicle collisions. Three mortalities appeared to result from collisions with light rail trains and one with an auto. Among the 5 colonies where trains traveled at a high rate of speed (20th, Sutterville, Redding Rd, Arden, El Camino), 3 (2.3%) of 128 adult nesting martins were found killed by trains. Two of the train-killed birds were color-banded, representing 8% of the 24 banded birds seen at all sites during 2007.

We recovered a total of 33 nestling fallouts from 82 nest sites monitored consistently, for an average loss of 0.40 young per nesting attempt. If fallout mortality is additive to other nestling mortality sources, rather being compensated by reductions in other sources of mortality, it represents a 12% productivity loss for the population (based on an average productivity of 3.4 young per nest. Six nestlings that fell from nest holes in 2007 were found alive and then successfully reared, color-banded, and released at colonies.

Feral Cat Population

During nesting surveys at the I St. colony, we discovered that six or seven cats were being fed daily at an unauthorized feeding station only 60 m from one of the primary areas that martins used to collect nesting material. Cats were regularly seen beneath nest sites and in areas where martins collected nesting material, although no stalking or predation on adults was observed in 2007. The extent of population decline at I St. in 2007 (-35%), although substantial, did not differ significantly from the declines at the other colonies (-23%; Table 1; $\chi^2_{1\ d.f.} = 0.17$, $p = 0.68$). Following an official notification of the cat caretaker that feeding was illegal and posed a threat to Purple Martins, he gradually reduced the number during September 2007-March 2008. As of April 2008, it appeared that no cats remained.

Land Use Threats

We identified 7 land use projects that are proposed beneath or immediately adjacent to Purple Martin colonies (Table 2). The projects occur at colonies that support 68% of the 2007 breeding population. Potential threats posed to colonies include direct disturbance during construction (a threat at all colony sites, not included in Table 2), loss of key habitat elements (perch sites, nest material collection areas, foraging space, flight access to colonies), or increase in mortality factors (vehicle collisions, starling competition, and feral cat predation). The magnitudes of threats posed by some of these projects are unknown, as specific project plans or incorporated mitigation measures to address impacts have not yet been provided or examined in detail.

Environmental Impact Reports (EIRs) for four projects we examined did not fully evaluate potential impacts to martin nesting colonies and identify mitigation. Of two projects near the Redding Rd. colony at I-50, one included provisions to survey potential nesting habitat for breeders and avoid direct disturbance of nesting during the breeding season (EDAW 2004), while the other contained no mitigation for effects on martin colonies (Nolte Associates 2004). Draft EIRs for several projects (Downtown Railyard redevelopment and the I-80 Across-the-Top carpool lane project) proposed to block martin use of nesting areas as the sole mitigation measure (PBSJ/EIP 2007, U. S. Department of Transportation and Caltrans 2007) without recognizing that displacement of breeders from sites likely would reduce reproductive success. None of these documents addressed longer-term effects of changes in habitat conditions or mortality factors. These issues were raised by us during the environmental review process for the Railyard and Across-the-Top projects, and were partially addressed during final project approval (PBSJ 2007) and subsequently (D Smoltz, Caltrans, pers. comm.; see Table 2).

Table 2. Potential Impacts of Projects Proposed at Purple Martin Colony Sites in Sacramento

Project	Affected Colony[1]	Impact Types	
		Habitat Losses	Increased Threats
Downtown Railyard redevelopment	I St	Perch sites, nest material site, flight space/access	Vehicle mortality, starling competition, cat predation
Mercy Hospital parking lot	S St.	Nest material site, flight space/access	
City of Sacramento parking lot	20th St	Nest material site	
Caltrans I-80 Across-the-Top carpool lanes	Roseville Road	Flight space/access	Vehicle mortality
Curtis Park West Railyard redevelopment	Sutterville	Perch sites, nest material site	Vehicle mortality, starling competition, cat predation
South 65th St. redevelopment	Redding Road	Perch sites, nest material site, flight space/access	Vehicle mortality, starling competition, cat predation
65th St. University Transit Village	Redding Road	Perch sites, nest material site, flight space/access	Vehicle mortality, starling competition, cat predation

[1] See Leeman et al. (2003) for colony locations

DISCUSSION

2007 Population

The nesting population decline in 2007 represents the third consecutive year of decline following 2 years of increases. The 2007 population size was lower than any recorded since prior to 2002 (Airola and Grantham 2007) despite broader survey coverage.

The general pattern of decline across most colonies in 2007 differs from 2006, when a nearly equal number of colonies had increased and decreased from the previous year (Airola and Kopp 2007). We previously suggested that the variability in population trends at different colonies in 2006 may have

resulted from local influences (e.g., cat predation, vehicle collisions) rather than regional ones (e.g., weather and food supply). The similarity in responses among colonies in 2007, however, is more typical of pattern observed in previous years (Airola et al. 2004, Airola and Kopp 2005). The similarity of the relative changes in colony sizes across all colonies in 2007 suggests that regional causes were more influential than local factors.

Stochastic factors (i.e., weather effects on survival and reproduction) may be contributing to recent population declines and, if so, populations may rebound in subsequent, more favorable years. Nonetheless, our monitoring over 2002-2007 demonstrates a lack of a positive population response, notwithstanding the application of management protections and enhancements during this period. Several colonies with a long-term history of occupancy (Broadway and 35th St.) have now declined to only a few pairs, which increases the risk of future wholesale colony abandonment.

Reproduction

Comparing reproduction in Sacramento martins to other populations is complicated by the use of different methods (i.e., remote camera viewing versus direct examination in nest boxes). High nesting success (96%) of Sacramento martins is one indication of healthy reproduction in the Sacramento population. The average 2007 productivity (young/occupied nest) of Sacramento martins (3.4) also was within the upper range of values reported for British Columbia (2.4-3.5; Cousens et al. 2005) and the eastern U. S. (2.1-4.1; Brown 1997). While conclusions from a single year of study are limited, there is no current indication that reproduction is problematic. Future monitoring should help provide a fuller picture of the reproductive performance of the population and allow application of population models that will clarify reproductive needs to sustain the population.

Mortality

The 2007 population decline by 25% from 2006 and the low proportion of color-banded birds resighted in 2007 (50%) compared to previous years (average = 67%; Airola unpub. data) suggest that high rates of adult mortality occurred between the end of the 2006 nesting season and the end of the 2007 season. We have only limited information, however, on the causes, their frequencies, and locations (i.e., within the breeding, migratory, or wintering range). Emigration from Sacramento colonies does not appear to be a cause of the population decline, because banded adult martins continue to show high site fidelity (Airola, unpub. data). Also, surveys of other suitable habitat in the area have not identified new populations occupied by adult birds, but rather only limited incidence of new colony colonization by second-year birds in their first breeding season (see Airola et al. 2004, Kopp and Airola 2007).

The Sacramento Purple Martin population continues to face ongoing and future challenges. Collisions of breeding adults with trains and cars at many colonies remain a concern, notwithstanding the difficulties of quantifying its magnitude (Airola and Kopp 2007). Cat predation at the I St. colony appears to be resolved for now, but remains a potential future issue there and elsewhere in this urban environment.

The frequency of nestling fallout (0.40 young per nest) in 2007 was generally similar to the 0.31 frequency found in during both 2005 and 2006 (Airola and Kopp 2005, 2007). The effect of fallout on reproduction is likely less than the crudely calculated 12% reduction (see Results). Most fallouts occur when birds are 8-16 days old (average = 11 days, Airola and Kopp, unpub. data), but our reproductive monitoring showed that additional nestling mortality likely occurs to older nestlings from causes other than fallouts prior to fledging at 28-29 days. Therefore, at least some of the productivity loss that resulted from fallouts would have occurred anyway (i.e., if they had not fallen, some of the same individuals would have suffered mortality from other causes). Also, loss of fallouts could have been partly compensated for by increased survival of remaining nestlings.

Land Use Threats

Our concerns about management of martin sites and longer-term effects of intensified urban land uses ('in-fill development") have heightened over the last 3 years, as the population has declined. Proposed projects that could disrupt nesting, modify habitat, or increase mortality at sites occupied by a high proportion of the remaining population are of concern, especially considering that existing conditions appear problematic. The lack of treatment of potential effects in project environmental documents (until we have raised issues) is also of concern. The individual and cumulative effects of current conditions with new projects deserve more careful attention.

D. Airola has recently participated with project lead agencies (Caltrans, City of Sacramento) to ensure that effects of site management, construction actions, and land use proposals on martin populations and habitat were fully recognized and addressed. It remains challenging, however, for a group of unaffiliated volunteers to marshal the effort required to get the attention of agencies to address these issues. We believe that preparation of a comprehensive plan is critical to guide future management of martin sites, treatment of sites during construction, and land use decisions. Such a plan could identify key habitat resources at each site, management issues and needs, analysis procedures to assess project impacts, and mitigation measures to reduce these effects. The plan would allow issues to be addressed routinely during early phases of project planning to avoid last-minute conflicts. To date, however, lead agencies have not committed to participate in preparation of such a plan.

Finally, as a result of the low population, recent declining status, and array of potential land use threats to Purple Martins, we have concluded that initiation of a nest box program is appropriate. Similar programs have enhanced the population status of martins in the Pacific Northwest (Cousens et al. 2005). In consultation with Stan Kostka, a manager of many martin box colonies in Washington, we have identified the Yolo Bypass region as an appropriate site because of high availability of aerial insect food, presumed lack of competing House Sparrows (*Passer domesticus)*, and proximity to existing colonies. Importantly, however, success in creating a nest box population depends on both a concerted effort to protect the bridge-nesting martin population in Sacramento as a source population and a long-term commitment to maintaining and managing the nest box sites.

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